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THE JOINT CITY, COUNTY, STATE, AND FEDERAL STUDY OF AIR POLLUTION IN LOUISVILLE, KENTUCKY

August T. Rossano, Jr.

Robert A. Taft Sanitary Engineering Center
Cincinnati, Ohio

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Robert A. Taft Sanitary Engineering Center
Cincinnati 26, Ohio

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ABSTRACT

This paper describes the planning and development of a cooperative study of air pollution in Louisville, Kentucky. The study, initiated January, 1956, is sponsored by the Jefferson County Air Pollution Control District under the technical direction of the Public Health Service in cooperation with the City-County Board of Health, the State Department of Health, the U.S. Bureau of Mines, the U.S. Weather Bureau, and the National Bureau of Standards and with financial support from the industries of Louisville.

Outlined in this paper is the plan of study which includes an inventory of air pollution sources, an odor survey, continuous air sampling, meteorological coverage, and other related activities.

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Louisville, Kentucky like many other American cities of its size has been experiencing for some years a growing urban air pollution problem associated with its industrial and economic growth. Prior to World War II its problem was largely one of smoke and flyash, the cause of which was limited chiefly to domestic and industrial use of coal as a fuel. During the war and post-war years the character of air pollution in Louisville shifted from smoke and flyash to the more heterogeneous type involving emissions of a variety of gases, fumes, dusts, and odors more characteristic of an urban complex.

The advent of World War II cut off this country's vital supply of natural rubber. To meet the growing need for rubber products, the Federal Government embarked on an intensive program of synthetic rubber production. Louisville was one of the locations selected for this purpose. In 1941 the first of a number of large plants for production of chemical rubber was built in an industrially zoned area on the southwest side of the city. Several other plants followed and within a short time there sprang up in this area a dense network of plants producing rubber or its components. The area appropriately enough became known as Rubbertown.

Shortly after these plants went into production, residents of the West End, a residential area adjacent to the northern edge of Rubbertown, began complaining of discomfort from odors, dust, and eye irritation. The emergence of this new type of air pollution was generally attributed to operations in Rubbertown.

Geographic and Topographic Factors

Louisville is a city of approximately 400,000 population on the south bank of the Ohio river in western Kentucky, about 100 miles downstream from Cincinnati, Ohio. (Fig. 1). The city covers an area of 50 sq. miles on flat terrain, 400 ft. above mean sea level, representing the old flood plain of the Ohio. The adjacent terrain, across the river in Indiana to the west, rises abruptly to a range of hills running almost north and south at a maximum elevation of about 900 ft. The terrain in the other directions is flat with a few gently rolling hills.

Climatologic Factors

The climate of Louisville is of the continental type affected by the westerly movement of winds and cyclonic and anticyclonic storms as well as the great source of moisture represented by the Gulf of Mexico. Winters are moderately cold with snowfall generally light. The summers are warm but rarely exceeding 100°, with high relative humidity. Heavy fog, while unusual, may occur between September and March. The most frequent wind direction during most of the year is southerly. Average wind speeds vary from eleven miles per hour in March to about six and one half miles per hour in August.

History of Air Pollution in Louisville

In 1946, when urban air pollution became significant, Louisville established a Smoke Commission, which in 1951 became the Louisville Air Pollution Control Commission. In July, 1952, following the enactment of a State air pollution enabling act, a county-wide air pollution control program was established with creation of the Jefferson County Air Pollution Control District, the jurisdiction of which extends to all cities within the county.

As stated previously, almost from the initiation of operations in Rubbertown public protests of annoying dust, fumes, gases, and odors began pouring in. Several unsuccessful attempts were made by local citizens to bring court action against Rubbertown industries. (Fig. 2).

Two studies were made by the University of Louisville to determine the nature and source of air pollution in the West End. In June, 1952, the Battelle Memorial Institute began an 18-month study sponsored by the eight Rubbertown industries. The findings of these studies shed some light on the problem, but because of their limited scope the results were not sufficiently conclusive to pinpoint the specific sources causing the complaints.

In July, 1955, President Eisenhower signed Public Law 159, which authorized the Public Health Service to establish a program of research and technical assistance in air pollution. Within a few days the Public Health Service received an official request from the Jefferson County Air Pollution Control District for technical assistance in dealing with the West End pollution problem. Following preliminary negotiations, the Service made a proposal for a joint Federal, State, and local study. The interested agencies formally agreed to this proposal in October, 1955, by the acceptance of a Memorandum of Agreement.

The purpose of this paper is to describe the planning and development of this study, which was formally initiated January 2, 1956. The schedule calls for six months to get the study into full scale operation, one year of detailed study and observation, and three to six months to evaluate and report findings.

Memorandum of Agreement

The Memorandum of Agreement is a document setting forth the terms and conditions of the study. The four designated cooperating agencies are the Air Pollution Control District of Jefferson County, the Louisville and Jefferson County Board of Health, the Kentucky Department of Health, and the Community Air Pollution Program of the Public Health Service.

The broad objectives of the study, as stated in the agreement, are to augment existing knowledge of the nature, extent, and sources of the problem as a basis for developing a rational program of control. The agreement stipulates that the study shall be under the technical direction of a representative of the Community Air Pollution Program of the Public Health Service, Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio.

A Steering Committee, consisting of one representative from each of the four participating agencies, is established to assist the technical director in nontechnical matters. It is further agreed that the director, who also serves as executive secretary of the Steering Committee, shall present monthly progress reports to the Steering Committee. The release of nontechnical information to the general public shall be by unanimous approval of the Steering Committee. Final reports are to be issued jointly by the cooperating agencies.

The budget for this study is approximately $175,000 for the first year, with the expectation of renewal for a second year. Federal and local contributions are approximately equal, the former being as technical services and equipment. The local contribution is largely in funds with which to procure additional personnel, equipment, supplies, and services. Approximately half of the local funds were subscribed by industry.

Preliminary Operations

New personnel for the study were recruited through personal communication and advertisements in technical journals and local newspapers. Employment is by contract between the individual and the Jefferson County Air Pollution Control District. Responsibility for recruitment and selection as well as separation action rests with the technical director.

In addition to the technical director, the staff consists of an Engineer-in-Charge who is responsible for the operation of four sections, Administrative and Statistical, Engineering, Chemical, and Meteorological Services. In all, there are thirteen full-time employees including personnel from the local Board of Health, Air Pollution Control Board, and U.S. Weather Bureau. In addition, there are the services of several private and governmental consultants. Considerable part-time assistance is given the study by personnel from U.S. Bureau of Mines, National Bureau of Standards, and Public Health Service. A total of seven official agencies, in addition to the regular staff, participate in the study.

The offices for this study are in the West End and are rented on a yearly lease. The space of approximately 1,000 sq. ft. is divided into five offices and one engineering laboratory. Garage space for two vehicles, additional engineering laboratory operations, and storage has been leased in the vicinity. The chemical laboratories are provided by the Kentucky State Health Department and include three small laboratories, part of a larger laboratory, and use of equipment shared with State personnel.

Transportation consists of two automobiles rented from the City motor pool, two panel trucks and a large mobile laboratory on loan from the Sanitary Engineering Center. Instruments, supplies, and services other than those furnished by the Public Health Service are provided by the Air Pollution Control District on recommendation of the technical director.

Plan of Study

To implement the broad objectives of this study, activities are being carried out along several parallel lines. The first is a determination of the quality of the air in and around the West End. This involves analyses for various particulate and gaseous pollutants, as well as a study of the variations and fluctuations in their concentrations with respect to time and space. Time considerations include diurnal, seasonal, and long-range trends and patterns. The spatial factor involves comparisons of pollutant concentrations on the basis of their horizontal and vertical distribution.

The second major activity is a study of the interrelationship between air quality and both meso- and micrometeorologic factors.

In approaching the objectives of these two phases, four basic principles were adopted as guides:

1. Comprehensive or area-wide approach involving a network of fixed observation stations covering the area of interest.

2. Measurements on a simultaneous and continuous basis 24 hours a day, every day, including weekends and holidays.

3. Sampling periods as short as practicable to obtain data suitable for estimating diurnal patterns.

4. Thorough analysis of selected samples.

These principles apply to both of two related networks, one for air sampling and the other for meteorologic observations. In this approach, while sampling for particulates and gases is as complete as possible in terms of time and geographic area covered, intensive physical and chemical analyses are performed only on selected samples. This system permits more efficient use of limited analytic facilities and resources, since a more thorough examination of significant samples is possible. The importance of using sound judgement must be emphasized, and the need for establishing a rational basis for selection is obvious.

Air Sampling Network

The air sampling network, (Fig. 3), is laid out on concentric arcs 2 and 3-1/2 miles from Rubbertown as the center. Most of the stations are between 10° and 50° azimuth to provide greater coverage for the West End area and take into account the prevailing wind direction with respect to Rubbertown as a pollution source. Stations No. 1 and No. 3 are the corresponding upwind and downwind stations 3-1/2 miles from Rubbertown. Station No. 5 is on a line between Rubbertown and station No. 1 and collects data to indicate the influence of distance from the source. Stations No. 4 and No. 6 flank station No. 5 and increase the chances of collecting polluted air originating from Rubbertown. These three stations also provide information on the concentration gradient across the polluted air stream under prevailing wind conditions. Station No. 2, also on the 3-1/2 mile arc, is a control; that is, it usually collects typical samples of urban air not directly influenced by Rubbertown pollution. The use of equal distances from the source eliminates the distance factor as a variable in comparisons of station results.

In addition to these fixed air sampling stations there will be in operation at least one mobile station built into a 1-1/2 ton van truck, fully equipped. This unit will sample at selected sites for limited periods of time to supplement the fixed stations.

The sampling equipment presently employed in this network is the conventional high-volume sampler. (Fig. 4). Initially, the filter medium is glass fiber filter paper (Type 1106, supplied by the Mine Safety Appliances Company). Two high-volume samplers operate alternately at each site on an 8-hour cycle, collecting three samples daily per station. (Figs. 5 and 6). An automatic timer controls the change-over operation at night so that personnel need visit each station only twice daily, at 8 A.M., and 4 P.M.

Two innovations are the standard shelter, which was designed especially for this study, and the orientation of the main axis of the high-volume sampler in a vertical rather than horizontal plane, minimizing any preferential effects of wind direction.

In addition, there are A.I.S.I. filter-tape samplers modified to permit analysis of particulate matter by flame photometry. Dustfall containers and adhesive surfaces are likewise provided. Collected material is subjected to special morphological examination.

The analysis of particulates collected by the high-volume samplers consists of determinations of total loading and organic and inorganic fractions. (Fig. 7). In addition, chlorides, sulphates, and nitrates are determined by wet chemical methods. Finally, an analysis for nineteen cations is made by emission spectroscopy and flame photometry. (Fig. 8).

Nonspecific gas sampling on an intermittent basis includes the use of freeze-out traps using liquid oxygen, and evacuated glass, plastic and stainless steel containers. Collected samples are analyzed in the mass spectrometer at the National Bureau of Standards, Washington, D. C. Specific gases are sampled by conventional means including scrubbers, absorbers, impingers, and evacuated flasks. Continuous gas sampling is presently confined to an SO_2 recorder to be supplemented later by other SO_2 units of this type as well as other automatic sampler-analyzer equipment. Under development in cooperation with the Sanitary Engineering Center are continuous gas sampling techniques utilizing compression cylinders, resin, activated carbon adsorption, and gas chromatography.

Meteorologic Network

Considerable effort is being devoted to operation of a comprehensive meteorologic network by two staff meteorologists assigned by the Weather Bureau. There are four main meteorologic stations (Fig. 3), two of which coincide with stations No. 1 and No. 3 of the air sampling network.

The equipment at each of these stations consists of a 61-ft. aluminum and steel tower supporting a wind vane and anemometer wired to recorders housed at the base of the tower. (Fig. 9). In addition, each of these stations has a recording hygrothermograph and wet- and dry-bulb thermometers housed in standard Bureau shelters. Two more hygrothermograph recorders are situated at Iriquois Park, a high promontory on the south side of the city, and at Shawnee Park, in the extreme northwest section of the West End.

With the cooperation of the local broadcasting station, WHAS-TV, meteorologic instruments are being installed on a television tower. A wind vane will be installed at the 525 ft. level, and thermohms will be situated at the 50, 170, and 524 ft. levels. This equipment will be wired to continuous recorders housed at the base of the tower. Tower instrumentation will permit vertical soundings of the atmosphere for measuring its degree of stability. In addition, soundings by wiresonde are made periodically. Addition of a mobile meteorologic station to the network is planned, to supplement the fixed stations as in the air sampling system.

Inventory of Air Pollution Sources

The third important phase of this study is an inventory of air pollution sources in Rubbertown. The approach consists of preliminary studies to become familiar with the plant processes, materials, mechanical equipment, waste products, and points of emission. Detailed stack sampling operations also are being carried out in cooperation with personnel from the U.S. Bureau of Mines and the Sanitary Engineering Center to determine the amount and chemical composition of solid and gaseous wastes. In addition, such physical characteristics as size,

shape, and surface area of emitted aerosols are determined. The purpose of this phase of the study is not only to learn the nature and rate of industrial discharges from Rubbertown, but also to compile an inventory of sources for use by local authorities in planning and evaluating regulatory measures. Tracer studies are planned for the future to determine the range and influence of selected point sources.

Odor Survey

Another major phase of the study is a survey of the nature and origin of objectionable odors in the West End. The procedure includes a study of industrial operations and the collection and cataloging of samples of odorous material. Odor reference kits have been prepared for use by staff personnel and other cooperating individuals in making area surveys on a routine basis as well as during intense fumigations. Under development at the Sanitary Engineering Center is an olfactometer for quantification of odors.

Trained Observer Program

A pilot study is underway to determine the nature, extent, and relative frequency of intense local fumigations resulting in objectionable odors, excessive dust, or related discomforting conditions among residents of the West End. This undertaking is exploratory and will depend largely on the cooperation of a corps of trained volunteer observers who are located in the West End. Using a daily recording form, each observer submits monthly reports of odor, dust, or irritating pollution incidents. Observers are provided with reference kits containing ten characteristic odors.

This activity represents not only a means for determining the type, location, and frequency of annoying fumigations, but also provides an alerting system for dispatching emergency air sampling crews and equipment to an affected area to study pollution at its peak levels.

Data Reduction

Early in the planning stages it became apparent that the routine handling and reduction of the voluminous data and information collected during the study would constitute a formidable task. A working relationship was established with the analytical statistics group of the Sanitary Engineering Center to assist project analysts in this problem. In addition to advice and consultation in the design and planning of the survey, the Center assists in the reduction, analysis, and interpretation of data. Punch cards and electronic calculators are being used.

Public Relations

The field of air pollution is uniquely sensitive to public relations and opinion. This study gives full cognisance to the importance of maintaining an adequate public information activity. Special attention is being given to the development of a clear public understanding of the scope and general approach of the study, the participating organizations

and staff, and the amount and variety of detailed technical work required. The general public is being kept apprised of developments by successive news releases on what is being done and why. In addition, frequent talks are made before civic and technical organizations reporting on progress of the study. The ultimate aim is to produce a favorable climate of public opinion so that the final findings and conclusions will be of maximum use.

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